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Population Dynamics, Efficacy of Botanical Extracts and Synthetic Insecticides for The Control of Pea Leaf Miner (*Phytomyza horticola* Goureau) (Diptera: Agromyzidae) Under the Climatic Conditions of Baltistan, Pakistan

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Abstract
Field Studies were carried out for the effective management of Pea Leaf Miner (*Phytomyza horticola* Goureau) through synthetic insecticides CURACRON®, Belt ® and botanical extracts of Almond Extract, @3.00%, Walnut Extract @3.00 on seasonal plots of Pea plant at Baltistan region during 2015-16.The treatments were applied at their calculated doses, when 3-5 leaves per plant were emerged in the experimental plot. After application of treatments data were taken as by counting number of damaged leaves per plant from selected five pea plant in each plot. Data were noted as damaged leaves per plant after 1st week, 2nd week, 3rd week, 4th week and 5th week respectively. Overall percent damage per plant by Pea Leaf Miner, showed that statistically all the treatments were non-significant to each other but significantly different from control plot. Seasonal mean percent damage was the highest (9.12%) in the check plot while lowest percent damage (2.83%) was recorded from the plot treated with CURACRON® followed by Belt ®, Almond Extract, @3.00% and Walnut Extract @3.00 (2.93, 4.26 and 4.32 %) respectively. Population trend in relation with temperature revealed that there was a positive significant correlation ($p<0.005$) was found between population and temperature as every increase or decrease in temperature, showed fluctuation in the population of leaf miner in Baltistan region.

Keywords: *Phytomyza horticola,* CURACRON®, Belt ®, Almond Extract and Walnut Extract, Correlation

1. Introduction
(*Pisum sativum* L.) (Fabales: Fabaceae) is an annual plant. It is a cool season crop grown in many parts of the world grown for its edible seed. Pea plants are also grown for increasing soil fertility because its roots fix nitrogen in the soil, making it available for other plants. Peas are one of the most nutritious leguminous vegetables rich in health benefiting phyto-nutrients, minerals, vitamins and anti-oxidants, fresh peas pods are an excellent sources of folic acid and ascorbic acid 100 g of fresh peas provides about 65 µg or 16% of folic acid and ascorbic acid (GPP., 2009) [2]. It is grown in many tropical and subtropical countries including Burma, India, Ethiopia, Morocco, Columbia, Ecuador, Peru and Pakistan (Khan., 1991) [6]. Over the last decade, Canada has been the leading producing country of peas in the world [4]. In Pakistan, more than 100,000 hectares is under cultivation, yielding less than1000 kilograms ha-1 (Khan, 2013) [5].
Phytomyza horticola Goureau (Diptera: Agromyzidae) is one of the serious pest of pea causing about 90% damage to the pea crop by mining young leaves which leads to stunting and low flower production. The feeding behavior of leaf miner is unique they feed on mesophyll of leaf by making mines between the leaf surface that reduce photosynthetic ability of plants, reducing flower production, seriously affecting crop quality and making the crop unsalable. Pea leaf miner infestation causes severe economic losses in pea crop- by

reducing crop yield and contamination of crop for processing or fresh market. Plants representing Fabaceae serve as main host for leaf miner. (Ipe, 2010) [3].

Bio-pesticides are naturally occurring substances, such as microbes, Bt bacteria, plant extracts, fatty acids or pheromones. Their use is growing rapidly worldwide, and they are in demand for their value in IPM programs to enhance yields and quality along with their low impact on the environment, human health and natural enemies. Botanical extracts of neem and tobacco usually used as bio-pesticides however many other plants are under consideration for using as bio-pesticides. (Suman Gupta., 2010) [12].

Keeping in the view the commercial value of pea plant in Baltistan region the present investigation was carried out to find effective management and to minimize the economic losses caused by leaf miner. Leaf miner by its feeding behavior make mines in pea leaves that reduces photosynthesis and ultimately reduction in yield occur. The objective of research is to find better management and to check the effect of new synthetic insecticides and bio-pesticides for the control leaf miner.

2. Material and Methods

2.1 Field location

The field investigation was carried out in Randomized Complete Block design (RCBD) having five treatments and each treatment was replicated three times against pea leaf miner at Baltistan region during 2015-16. The Azad P-1 variety of Pea was sown in a plot size of 6x3m^2. Row to row and plant to plant distance maintained was 45-60 cm and 60-75 cm respectively. All the synthetic insecticides and botanical extracts were applied as foliar application when 3-5 leaves appear from pea plant emerged with the help of knapsack sprayer. The field investigation took about three month from sowing to data collection.

2.2 Plant material extraction procedure from Almond leaf and Walnut leaves

The Volatile Terpenes abstain from many trees were used for the control of insect pest. It was observed that walnut and almond plants in Baltistan region were usually not infested by pest as compared to other fruit and forest trees. So we check the effect of walnut and almond for control of leaf miner. (Zaka., *et al.* 2014) [13]. The fresh leaves of Almond and Walnut were collected from the local orchard of Baltistan region and washed with distilled water until the dust and other pollutants was completely removed after proper washing plant parts are allowed to shelter dry for one week. 50 gm of powdered botanicals extracts from Almond and Walnut leaves were weighed and then allowed to pass through a cellulose extraction thimble. Plant materials were properly extracted by using 250 ml ethanol for 5 hours at (78c) in a Soxhlet apparatus (250 ml) and the final obtain extracts were pour in to the glass flask separately. The abstract was measured and from each glass flask final 200 ml volumes was made and pour into the round bottom flasks. The glass flasks contain pure plant materials were fitted to the bottom of Rotatory evaporator (Buchi; R-114; Switzerland) separately and evaporated to dryness at a temperature 85c. Then flasks which contain plant dried materials were separated from the Rotatory evaporator and weighed. The weight of dried extracts of Almond and Walnut leaves were calculated by subtracting the already noted weight of empty round bottom flask, after weight in each flask coating plant materials few milliliters of ethanol were added to help in dissolution of extract with water. Finally add 50 ml of distilled water in the extract to get 1gml-1 (100% w/v) concentration (M. Prishanthini, 2014) [8].

2.3 Chemical control

Chemical treatments used are Difenthuron 500 G/L, Imidacloprid 25 w/p, Actara 25W/G and control plot. Recommended dose of pesticide were shown in (Table-I).The experimental plot was of 20m^2 consist of 40 plants per plot which was grown on bunds. All the pesticides were applied as foliar application by Knapsack sprayer formulation was made as the pesticide manufacture recommended. While leaves extracts of walnut and almond @3.00% were applied at rate of 30ml/liter of water. All the treatments were applied in month of June when 3-5-5 leaves per plant were emerged. After application of treatments data were taken as by counting number of damaged leaves per plant from selected five pea plant in each plot. Data were noted as damaged leaves per plant after 1st week, 2nd week, 3rd week, 4th week and 5th week respectively. (Shakur, 2007) [9].

Percent damage caused by leaf miner were count and converted into percent damage by the following formula

$$\text{Percent damage (\%)} = \frac{\text{No. of damage leaves}}{\text{Total number of leave}} \times 100$$

Table I: Treatment formulation and their calculated dose as per acre

Treatments	Active ingredient	Calculated dose Rate/5 lit water
1. Curacron® 500 EC	Profenofos	20mL/6x3m^2
2. Belt® 480 SC	Flubendiamide	20mL/6x3m^2
3. Almond leaves extract@3.00%	Almond extract	150ml/6x3m^2
4. Walnut leaves extract@3.00%	Walnut extract	150ml/6x3m^2
5. Control	…….	…….

2.4 Population of Pea leaf miner In relation to Temperature

Temperature was recorded from the nearest metrological station and was correlated with the population of leaf miner in Baltistan region. We continuously checking the pea plots in study area, every increase or decrease in temperature observation was taken to check the effect of temperature on population of leaf miner. Population of leaf miner was noted as number of leaf miner per leaf from selected five leaves per pea plant in each plot.

2.5 Statistical analysis

The experiment was laid out in randomized complete block design with three replications. The collected data was subjected to ANOVA and means was separated, using LSD test at 5% level of significance (Steel and Torrie, 1980) [10].

3. Results

Data of effectiveness of Insecticides and Botanical extracts were recorded after interval of 1st week, 2nd week, 3rd week, 4th week and 5th week respectively date were noted as number of damaged leaves per plant from selected five leaves in each plot. Data recorded after first week of application revealed that minimum percent damage recorded from the plot treated with Belt ® was 1.92% followed by CURACRON®, Almond Extract, @3.00% and Walnut

Extract @3.00% 1.92, 2.30, 2.40% respectively while maximum percent damage recorded from the check plot was 3.33%. The 2nd data were recorded after two week application of treatments data recorded in 2nd week revealed that minimum percent infestation recorded from the plot treated with CURACRON® was 2.13% followed by Belt ®, Almond Extract, @3.00% and Walnut Extract @3.00% were 2.16, 3.17 and 3.23% respectively on the other hand from control plot 7.17% percent damage was recorded. The percent damage data recorded in the 3rd week after application of treatment revealed that minimum damage recorded from the plot treated with CURACRON® was 2.67% followed by Belt ®, Almond Extract, @3.00% and Walnut Extract @3.00% were 2.7, 3.96 and 3.87% respectively while in control plot maximum percent damage recorded was 9.11%. Data of 4th week revealed that lowest percent damage recorded from the plot treated with CURACRON® was 3.14% followed by Belt ®, Almond Extract, @3.00% and Walnut Extract @3.00% were 3.33, 5.78 and 5.87% respectively while in control plot maximum percent damage recorded was 13.23%. Due to decreasing the effect of treatment in 5th week the rate of percent damage slightly increase in the plot treated with synthetic insecticides recorded were CURACRON® 4.33 and Belt ® 4.51 % while percent damage recorded from the plot treated with botanical extracts showed maximum percent damage recorded were Almond Extract @3.00% 6.13% and Walnut Extract @3.00% 6.54% while severe percent damage was recorded from the check plot was 13.23%. All the treatment effect was statistically significant (P<0.05) from each other as compared to control plot but statistically non-significant to each other (Table-II).

Table II: Percent damage per plants by *P. horticola* larvae in response to various treatments

Treatments	Percent Damage after 1st week	Percent Damage after 2st week	Percent damage after 3rd week	Percent Damage after 4th week	Percent damage after 5th week	Overall mean
CURACRON®	1.92a	2.13a	2.67a	3.14a	4.33a	2.83
Belt ®	1.88a	2.16a	2.77a	3.33a	4.51a	2.93
Almond Extract @3.00%	2.30b	3.17b	3.96b	5.78b	6.13b	4.26
Walnut Extract @3.00%	2.40b	3.23b	3.87b	5.87b	6.23b	4.32
Control	3.33c	7.17c	9.11c	12.22b	13.23c	9.12

3.1 Mean in column followed by dissimilar letters are statistically different at 5 % level of probability.

The lowest mean Percent damaged for the whole season was observed in the Plots treated with CURACRON® was 2,83% followed by Belt ®, Almond Extract, @3.00% and Walnut Extract @3.00% were 2.93, 4.26 and 4.26% while highest mean percent damage recorded from control plot was 9.012%. (Fig-I) the findings of our investigation was similar to the finding of (Shakur, 2007) [9].

3.2 Population dynamics of leaf miner in relation to temperature

Data showed that temperature was optimum in July which ranged from 22-27c. The population of leaf miner reached to its highest during July Fig. I After 5th of August temperature starts fall in Skardu region as every increase or decrease in temperature in study area a decline in population of leaf miner were observed lowest population of mite were noted during month of August. A significant positive correlation (P<0.005) was found between the population of leaf miner and temperature. Our findings are similar to Pregner and Ling (2001) [7].

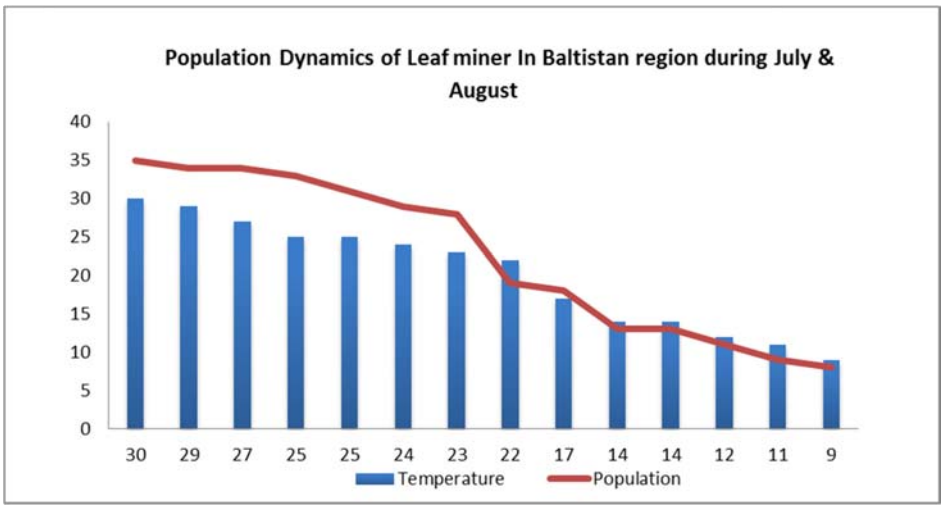

Fig I: Number of leaf miner per plant recorded from selected five leaves per pea plant in July and August

4. Discussion

Pea plant has commercial value in Baltistan region as its consumption is in both farms fresh and cooked. Baltistan is located in north of Pakistan at elevation 2,500 meters (8,202 feet) (Adle, 2003) [1]. Present investigation revealed that for the control of leaf miner in Baltistan region CURACRON® proved best as the lowest mean Percent plants damaged for the whole season was observed in the Plots treated with

CURACRON® was 2.84%. Botanical extracts of walnut and almond showed good results but low as compared to synthetic insecticides. Present results of study were quite similar to the findings of Karar (2010) [5], Suss (1978) [11]. Temperature has a great influence in the population dynamics of pea leaf miner population observed during the field investigation.

5. Recommendation

It is concluded from the present study that CURACRON® is more effective against pea leaf miner as compared to Belt ®, Almond Extract, @3.00% and Walnut Extract @3.00%. Lowest percent damage was recorded from the plot which was treated with CURACRON® for control of pea leaf miner. It is suggested from the above that to overcome the severe infestation by leaf miner at Baltistan region we recommend use of CURACRON® for its effective control. that there was a positive significant correlation ($p<0.005$) was found between population and temperature as every increase or decrease in temperature, showed fluctuation in the population of leaf miner in Baltistan region

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